

In those sections devoted to paper testing, which make up more than half the volume, the author takes pains to make his exposition lucid. We note an occasional slip, as in dealing with the question of a coloured ash left on burning a paper. "If blue, ultramarine, Prussian blue, or smalts may be present." This must be corrected as regards the cyanide blue. Again:—"the blue is tested by boiling with caustic soda and filtering." "The Prussian blue passes into solution." This inaccuracy will be evident to the chemist.

In the section on the estimation of moisture we find the expression "bone dry" for "oven dried." Bones are not dry to the chemist, only to the poet.

In the "dictionary of chemical terms" and the "glossary of various papers" which make up the concluding chapters we also note a number of slips, which perhaps may be explained by the laudable aim at short, crisp definitions; but this hardly excuses the description of caustic soda as "prepared by boiling carbonate of soda with quicklime"; bleaching powder as a "dry pulverulent powder prepared by exposing dry powdered quicklime to chlorine gas"—the italics here are our "note of exclamation"; "dextrine" as industrially obtained "by the action of boiling dilute sulphuric acid on starch"; "dicotyledon" as including the Coniferæ with angiosperms, such as beech and ash.

These descriptive terminologies are excellent in plan, and generally useful. They should be carefully revised, and perhaps amplified, in future editions. A section on bibliography would be a useful addition, and we think it is due from the author to acknowledge more fully the sources of much of the matter in this book, especially the German text-books and publications, of which he fully avails himself. The book is fully illustrated, and the matter thereby pointed and elucidated.

It is evident that the work is one we can appreciatively commend to the very wide circle of those interested in "paper"; as for the paper-makers, the author only indulges, with becoming modesty, the "hope that this book may prove useful to them." We think they will see the value of keeping pace with the critical knowledge of the consumers.

WEIGHTS AND MEASURES.

Outlines of the Evolution of Weights and Measures and the Metric System. By Dr. William Hallock and Herbert T. Wade. Pp. xi+304. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1906.) Price 10s. net.

THE literature of weights and measures is very extensive, and, as a rule, singularly uninteresting. Messrs. Hallock and Wade are therefore to be congratulated on having produced a treatise on the subject which is at once instructing and attractive. For this is an admirable piece of work, in which the result of much tedious research is presented in a bright and lucid narrative. The first chapter is devoted to a brief review of the speculations of metro-

logists and antiquaries concerning the weights and measures of the ancients. It includes a particularly good account of the Babylonian units and the various theories respecting them which have been deduced from the Senkereh tablet and the scale of Guldea. After a rapid survey of the weights and measures of the Hebrews, the Greeks and the Romans, the authors pass on to consider the systems in vogue in Great Britain and in France from the earliest times up to the end of the eighteenth century. The next two chapters and the fifth deal with the origin and extension of the metric system. They trace the system from its embryonic stage in the writings of Mouton, Picard, Huygens, and Cassini, to its fully-elaborated form in the law of April 7, 1795. The geodetic work of Delambre and Méchain is next described, and the opportunity is taken to introduce short explanations of a trigonometrical survey and of the determination of latitude. An account follows of the construction of the metric standards of the French Archives and of the lengthy interregnum of *mesures usuelles*.

The meeting of the International Geodetic Association at Berlin in 1867 marks an important epoch in the history of the metric system. The authors describe the influential part played by it in securing the establishment of the International Metric Commission. This leads to an interesting account of the International Committee of Weights and Measures and its bureau at Sevres. In this connection it may be mentioned that, owing to the death of the British representative early last year, this country is at present not represented on the International Committee. The power of appointing a member to fill the vacancy rests with the committee itself. In 1884 the committee had some difficulty in finding a suitable representative for this country owing to the fact that the officer in charge of our Standards Department at that time, although an official of standing, was comparatively unknown in the scientific world. At the present time, now that all the metric prototypes have been distributed, and thus the most important object of the convention achieved, it is absolutely necessary in order that the United Kingdom may continue to derive any advantage from its contributions to the funds of the Metric Bureau, that the representative of this country on the committee should be an official of the Government department which is charged with the construction and preservation of the Imperial and metric standards. It will accordingly, no doubt, be a matter of considerable satisfaction to the International Committee that the recently appointed Deputy Warden of the Standards is an eminent man of science, in every respect worthy of membership in that distinguished body which has included on its roll such names as Mendeléeff, Bertrand, Foerster, Mascart, Christie, and Michelson.

In their fourth chapter Messrs. Hallock and Wade have set themselves the congenial task of explaining the standards of weight and measure in vogue in their own country. The desirability of a simple and uniform system of weights and measures was fully

realised at an early stage of the existence of the United States. Washington devoted much attention to this subject, and it was under his direction that in 1791 a committee of the Senate entered upon a very full consideration of the questions involved. They reported in favour of a decimal system, and recommended the adoption of a standard of length divided into five equal parts, each of which would correspond to a foot. No legislative action was taken, however, to give effect to these recommendations. In 1819 a committee of the House of Representatives submitted a report advocating that models of the yard, bushel, and pound, conforming to those in most common use, should be made and adopted as the standard weights and measures of the United States. This proposal also proved abortive. The elaborate report prepared in 1821 by Mr. Secretary (afterwards President) Adams, a warm admirer of the metric system, was likewise without any immediate effect. The metric system was not seriously considered in the United States until 1866, when the use of the system was authorised by Congress. In 1889 copies of the international metric standards were distributed by the International Committee to the various States which were parties to the Metric Convention. The copies received by the United States were immediately adopted as primary standards, and in 1893 a formal order of the Treasury Department recognised the international prototype metre and kilogram as fundamental standards, and directed that the customary units, the yard, and pound were to be derived therefrom.

Chapters vi., vii., and viii. deal with the advantages which would be derived from the universal employment of the metric system in commerce, manufactures, and medicine. The authors admit having a bias in favour of this system, and they make out a very good case for its general adoption. In the next chapter international electrical units are considered, and attention is directed to the benefits conferred upon electrical science by the introduction of the C.G.S. system at the instance of the British Association. The United States specifications for the practical application of the definitions of the ampere and volt were prepared by the National Academy of Science in 1895, in compliance with the provisions of an Act of Congress. These specifications, which are quoted *in extenso* on pp. 211-215, differ in some slight respects from those prepared in this country about the same time by the Board of Trade.

A most instructive chapter is the tenth, which relates to the construction and comparison of standards. The various physical properties which should be possessed by primary standards are discussed, and an account is given of the different alloys which have been used in the construction of such standards. The relative merits of line and end standards are next considered, the method of subdividing a scale by means of a dividing engine being well described. It is mentioned that at the International Bureau the graduation of a metre into millimetres in this way occupies about sixteen hours. The footnote on p. 226

quoted from Guillaume appears to contradict the statement in the text respecting the accuracy attainable by this method.

A very good description is given of the comparators employed in the verification of standards of length, and the mode of using them is explained. After some account of balances of precision, the British imperial standards of length and weight are described with illustrations. The name of Mr. Chaney, the late superintendent of weights and measures, is misspelt on p. 247, and the position which he occupied is inaccurately designated as Warden of the Standards. The latter office has been since 1878 an honorary adjunct to the permanent secretaryship of the Board of Trade.

The chapter concludes with a simple and interesting explanation of measurement by means of wavelengths of light. This method was originally only applicable to the measurement of very short intervals, but Michelson has extended its application to lengths of any magnitude. It is of great interest in metrology, since by making re-determinations from time to time positive testimony may be obtained as to whether any variation is taking place in the length of a standard. At the present day the permanency of bronze standards of length is regarded with suspicion by metrologists. The authors refer on p. 219 to the fact that many of the bronze copies of the British yard which were distributed to various nations and scientific institutions in 1855 are believed to have since undergone changes in length due to molecular rearrangement. This casts some doubt upon the invariability of the Imperial Standard Yard, which is made of the same material. The recent developments of Michelson's method afford a ready means of deciding this important question.

Some useful tables are appended, and a comprehensive index brings this well-conceived work to a close.

ITALIAN SCIENTIFIC WORKS.

- I grandi Trafori Alpini.* By G. B. Biadego. Vol. i. Pp. xvi+1228; in addition to about 36 folded pages of tabular matter. Vol. ii. 30 large folded plates. (Milan: Ulrico Hoepli.) Price 45 lire (1l. 16s.).
- Opere matematiche di Francesco Brioschi.* Vol. iv. Pp. ix+418. (Milan: Ulrico Hoepli, 1906.) Price 1l.
- I Motori a Gaz.* By Vittorio Calzavara. Pp. xxx+424. Manuelli Hoepli. (Milan: Ulrico Hoepli, 1906.) Price 4.50 lire.
- I Motori ad Esplosione, a Gas luce e Gas povero.* By Ing. Fosco Laurenti. Pp. xii+361. Manuelli Hoepli. (Milan: Ulrico Hoepli, 1906.) Price 4.50 lire.

THE opening of the Simplon tunnel amid a flourish of Italian trumpets was a fitting opportunity for the publication of a book dealing with this and other mountain borings. That the author might have written a book on the Simplon tunnel alone is evidenced by the fact that the part he devotes to this tunnel occupies the space of an average-size volume